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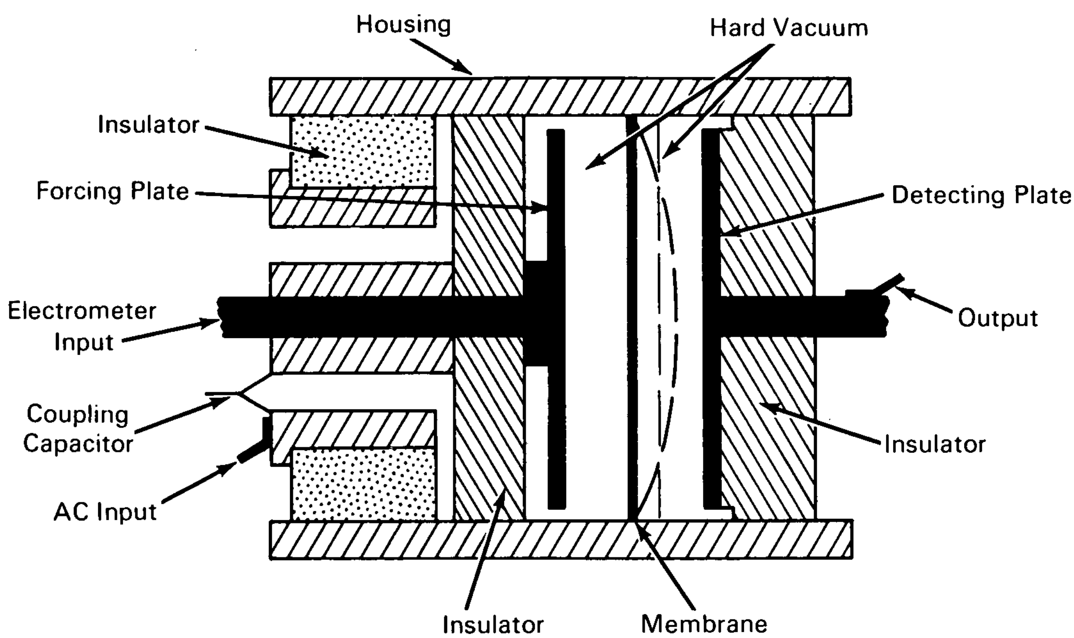
Vibrating-Membrane Electrometer Has High Conversion Gain



The problem: Devising a technique that would allow measurement of currents below 10^{-17} ampere in a small, rugged transducer with high conversion gain and minimum internal power consumption.

The solution: An instrument employing a vibrating-membrane transducer in a circuit that utilizes its characteristics to provide a conversion gain three orders of magnitude greater than that of present electrometer transducers.

How it's done: The electrometer embodies a combination of mechanical and dynamic capacitance principles. Basically, the membrane is driven at its resonant frequency by an electrostatic force which is derived from voltages applied between the membrane and a stationary forcing plate in close proximity to one side of the membrane. The electrometer input current controls the displacement amplitude and affects the capacitance which is developed through the mechanical resonant properties of the membrane to provide a high conversion gain. This is accomplished with a drive voltage of two components: the first, a large sinusoidal voltage at resonant frequency, 90° out of phase to the membrane motion; and the second, a steady voltage derived from the small input current to be measured. A high conversion gain is obtained by using the voltage from a small input current as a dc voltage to control the membrane displacement amplitude when driven at its resonant frequency. Since the

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transducer has an excellent arrangement for shielding, high voltage may be applied to its detecting side to provide a large ac output signal. The result is an amplified sinusoidal voltage which is proportional to the high mechanical Q of the membrane. The electrometer is capable of conversion gains of 2×10^{3} in voltage and 2×10^{12} in current, giving a 4×10^{15} power conversion gain.

Notes:

1. A model using this technique was constructed; it has an input impedance of better than 10^{16} ohms and is sensitive to less than one millivolt impressed on the forcing plate from the low-impedance source. The results of initial tests indicate that a compact, rugged instrument can be developed capable of measuring currents smaller than 10^{-17} ampere with low internal power consumption.
2. Inquiries concerning this invention may be directed to:

   Technology Utilization Officer
   Ames Research Center
   Moffett Field, California, 94035
   Reference: B65-10056

Patent status: NASA encourages the immediate commercial use of this invention. Inquiries about obtaining rights for its commercial use may be made to NASA, Code AGP, Washington, D.C., 20546.

Source: John Dimeff and Grant W. Coon,
(ARC-38)